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Investigating the readiness of people in manufacturing SMEs to embark on Lean Six Sigma projects

An empirical study in the German manufacturing sector

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Abstract

Purpose – The purpose of this paper is to focus on three fundamental human-related behaviour factors associated with Lean Six Sigma (LSS) projects in German manufacturing small-and medium-sized enterprises (SMEs) on the readiness of people (managers and their staff) to commence LSS projects. These are core personal competence, strategic vision of the people and the organisational culture of the specific organisation.

Design/methodology/approach – Based on a thorough review of the academic literature a set of hypotheses were constructed to examine the level of association between people's competence, vision and culture with LSS readiness within SMEs. This was done using correlation and regression analysis. Data collection were carried out in seven different German manufacturing SMEs involved in aerospace supply and agro-food manufacturing using a survey instrument.

Findings – It was found that there is a strong positive association between the core competence of people and organisational culture with readiness for commencing LSS in the manufacturing SMEs studied. The core values of people, education level and the vision of making continuous quality improvement were identified as key variables in promoting LSS readiness in these manufacturing SMEs. This study indicates that these "softer" variables can be essential to successful LSS implementation and need to be explored further before undertaking the process.

Practical implications – From the perspective of the implementers of LSS the results of this research could be of interest to different manufacturing SMEs intending to embark upon an LSS journey as it highlights the significance of human-related behavioural factors in the process. SME organisations may consider carrying out development or training with their managers and employees around personal and organisational values, addressing core competence and strengthening organisational culture in order to facilitate LSS readiness and enhance the prospect of its success.

Originality/value – It would appear that this LSS research has not been carried out within the German manufacturing SME context before and although discrete in nature has surfaced the "softer"

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variables of core competence of staff and organisational culture as important readiness issues to address when undertaking LSS. This integrated approach of human behavioural factors, organisational culture, LSS and manufacturing SMEs demonstrates the originality of the research.
Keywords Six Sigma, SMEs, Human resources management, Manufacturing strategy, Lean Six Sigma, Key success factors

Paper type Research paper

1. Introduction

Organisations of different sizes and in a variety of sectors are constantly being faced with a growing competitive environment as well as relentless pressure from customers to maximise value in both products and services (e.g. Felsted and Smith, 2015). Lean Six Sigma (LSS) is a business improvement strategy that has flourished over the last decade because of its promise of enhanced business performance and market capability. LSS has evolved through the combination of Lean and Six Sigma, both recognised as leading total quality management (TQM) tools for performance improvement in organisations with a proper infrastructure built on leadership and change culture (Dora and Gellynck, 2015; Assarlind *et al.*, 2013; Wang and Chen, 2012; Choi *et al.*, 2012; Hilton and Sohal, 2012; Atmaca and Girenes, 2013; Lee *et al.*, 2011; Delgado *et al.*, 2010; Dahlgaard and Dahlgaard-Park, 2006; McAdam and Lafferty, 2004). LSS is now regarded as one of the most effective and disciplined business transformation initiatives available in strategic operations management as well as an effective top-down methodology for improving quality in both the manufacturing and service small- and medium-sized enterprise (SMEs) and their larger counterparts (Kanpp, 2015; Isa and Usmen, 2015, Bhat *et al.*, 2014, Algassem *et al.*, 2014; Biranvand and Khasseh, 2013).

Despite a great deal of Six Sigma and LSS publications during last two decades, individual personnel behaviour and related attributes have been seriously neglected in the LSS empirical research literature (Stanton *et al.*, 2014; Jimenez-Jimenez and Martinez-Costa, 2009). This is even more apparent within the SME manufacturing sector, where there appears to be much less understanding of issues around LSS implementation and the role of the SME employees and managers in the process (Dora and Gellynck, 2015; Shokri *et al.*, 2014; Timans *et al.*, 2012; Pepper and Spedding, 2010). The term SME for the purposes of this study uses the EU definition of any organisation with less than 250 employees (European Commission, 2003; Department of Trade and Industry, 2005 cited in Kumar *et al.*, 2009).

It is also clear from a number of research studies that LSS is not dissimilar to many other TQM practices and because of this is heavily dependent on collective, individual, team and organisational learning behaviour as well as organisational or individual interests to create knowledge and skill (Lam *et al.*, 2015; Calvo-Mora *et al.*, 2014; Arumugam *et al.*, 2013; Hilton and Sohal, 2012; Neumann and Dul, 2010; Baird *et al.*, 2011; Soltani and Wilkinson, 2010; Jimenez-Jimenez and Martinez-Costa, 2009).

Apart from a few opinion pieces which focus on human resource issues and readiness for LSS implementation in the service sector (Antony, 2014; Stanton *et al.*, 2014; Bamber *et al.*, 2014; Fazzari and Levitt, 2008; Hensley and Dobie, 2005), no rigorous research evidence has emerged that explores the role of organisational and individual behavioural factors in promoting readiness and enabling LSS in the manufacturing SMEs. Moreover, the few articles that are available are not supported by empirical research. This issue has also been highlighted by Zhang *et al.* (2012) who through extensive secondary data analysis have found that there needs to be

more focus on exploring the emerging theory of implementing LSS in SMEs and also more research emphasis on LSS integration with the human behavioural aspects of organisations.

The purpose of this paper is to investigate the people-related behavioural aspects of top management commitment and organisational resistance as two key elements in manufacturing SMEs prior to commencing a LSS programme. Our intention is to identify the key human behavioural factors of SMEs' employees and managers that have an impact on readiness to embark on LSS. According to Antony (2014) and Lee *et al.* (2011), LSS readiness means awareness of terminology, principle and benefits, eagerness to work in team projects and eagerness to work with data and statistics. It is these elements that have been selected as key constructs of LSS readiness within this research. The next section presents LSS principles, benefits, limitations and critical success factors (CSFs) in manufacturing SMEs to provide the platform of developing the research hypothesis. Section 3 then discusses the hypothesis development and explores core personal competence, strategic and operational vision and organisational culture before presenting the research model used in the German manufacturing SME study. Section 4 outlines the research methodology which is then followed by the research findings, discussion and conclusions.

2. LSS in manufacturing SMEs

It is evident from the literature that LSS is a process improvement strategy in which people play an important role. Their personal competence, vision and culture influence the readiness for embarking on LSS in manufacturing SMEs and therefore must be related to top management commitment as well as organisational resistance (Antony, 2014; Albliwi *et al.*, 2014). The goal of LSS, similar to Six Sigma, is to focus on low hanging fruits and eliminate waste factors known as defects by accomplishing a near perfect quality level through the systematic removal of causes of the defects (Dora and Gellynck, 2015; Choi *et al.*, 2012). LSS benefits from both Six Sigma and Lean by incorporating a focus on cost, process cycle time, delivery value and efficiency from Lean and Kaizen and sustainable and incremental process improvement and profitability from Six Sigma (Bamford *et al.*, 2015; Holmes *et al.*, 2015; Worley and Doolen, 2015; Atmaca and Girenes, 2013; Sarkar *et al.*, 2013; Womack and Jones, 2005). At an operational level within the manufacturing sector, the LSS model aims to clarify the process of identifying opportunities, as well as reduce variability and improve the quality of the manufacturing process (Holmes *et al.*, 2015; Thomas *et al.*, 2009).

As two key components of LSS, Six Sigma is primarily a systematic and rigorous tool to uncover and reduce defect and variation in breakthrough projects, whilst Lean management focuses on continuous incremental reduction of waste, environmental sustainability, increasing the speed of the operation and delivering the value (Bamford *et al.*, 2015; Piercy and Rich, 2015; Choi *et al.*, 2012; Hilton and Sohal, 2012; Assarlind *et al.*, 2012; Manville *et al.*, 2012; Womack and Jones, 2005). A number of organisations have adopted LSS as the strategy for finding the balance between quality, cost and delivery (Antony, 2014) in a continuous improvement or breakthrough improvement approach (Assarlind *et al.*, 2013).

LSS projects focus on customer needs, financial enhancement (Shafer and Moeller, 2012; Cournoyer *et al.*, 2013), improved efficiency (Jayaraman *et al.*, 2012) and process improved cycle time (Gupta *et al.*, 2012) by reducing the variation in process, reducing non-value adding activities, better decision making and improved employee morale (Manville *et al.*, 2012; Thomas *et al.*, 2009; Biranvand and Khasseh, 2013). These benefits

are also being extended to manufacturing SMEs, where the application of LSS appears to be increasingly in vogue (Dora and Gellynck, 2015; Thomas *et al.*, 2009; Gijo *et al.*, 2014; Cournoyer *et al.*, 2013). By utilising the LSS five-phased systematic methodology of define, measure, analysis, improve, control (DMAIC) SMEs can tackle their own specific problems (Gupta *et al.*, 2012). Nevertheless LSS has its critics.

For example, Bendell (2006) cited in Pepper and Spedding (2010), argues that LSS is a combination of two ill-defined and non-compatible tools and other literature has also suggested "internal resistance", "the availability of resources", "changing business focus" and "lack of leadership" are the greatest impediments to change in any manufacturing SME (Timans *et al.*, 2012). Yet despite this there are still a growing number of research articles highlighting the role of LSS or Six Sigma in manufacturing SMEs in improving quality, cost efficiency and profitability (Dora and Gellynck, 2015; Wang and Chen, 2012; Kumar *et al.*, 2011; Antony, 2008; Thomas *et al.*, 2009). When some of this research is explored closely it is clear that there are parallels with other areas of operations management. For example, a longitudinal study of LSS found a positive association between human resource management practices such as empowerment, extensive training and teamwork with TQM in the manufacturing and service sector (Lam *et al.*, 2015; Stanton *et al.*, 2014; Menezes *et al.*, 2010). A further LSS study in the large "heavy automotive manufacturing supply" sector in developing countries (e.g. Turkey) has also suggested that human factors including culture, educational level and knowledge of statistics have an impact upon success which mirrors research done on Six Sigma projects (Tanik and Sen, 2012).

Some research studies have suggested that the application of LSS in SMEs needs to take a different perspective in comparison to studies within larger organisations when it comes to resources and HR aspects such as training (Kaushik *et al.*, 2012; Kumar *et al.*, 2011; Thomas and Barton, 2006; Nabhani and Shokri, 2009). Nevertheless it has also been argued that there is nothing inherent in Six Sigma or LSS that makes it more suitable in larger companies (Kaushik *et al.*, 2012) if resource management and cost-effectiveness are considered as the primary motivation of change in SMEs (Thomas *et al.*, 2009). To date LSS research in SMEs has mainly focused on the mechanistic aspects of the approach such as the application of the DMAIC methodology within the manufacturing sector, rather than the more strategic perspectives and softer elements and these need to be addressed. (Prashar, 2014; Atmaca and Girenes, 2013; Sharma and Sharma, 2013; Kaushik *et al.*, 2012; Antony *et al.*, 2005, 2012; Wang and Chen, 2012; Thomas *et al.*, 2009; Kumar and Antony, 2009; McAdam and Lafferty, 2004).

It is argued in the literature that one of the key distinctive characteristics of LSS is its sense of urgency and appropriateness to solve complex cross-functional problems to reduce undesirable variations in manufacturing processes (Antony *et al.*, 2012). Addressing the "people" issue has been suggested as one of the key fundamental factors to enhance SMEs' ability to implement LSS. Nevertheless SMEs are also suffering from a lack of knowledge and confidence in using technical and statistical tools (Thomas and Barton, 2006). Antony *et al.* (2005) contend that more people orientation and top management physical presence and availability are key strengths in SMEs and this is congruent with later research, which suggests that the main people-related CSFs in manufacturing SMEs for the implementation of Six Sigma are in fact similar to bigger organisations, e.g. top management support, teamwork, leadership, training and cultural change (Choi *et al.*, 2012; Kumar *et al.*, 2009; Nakhai and Neves, 2009; Kumar and Antony, 2008). In terms of barriers to the successful implementation of LSS in manufacturing SMEs, research has proposed that resistance to change, lack

of management support, organisational culture, a lack of appropriate training, knowledge and awareness are all relevant factors when considering taking an LSS approach (Prashar, 2014; Antony, 2012; Aboelmaged, 2011; Kumar and Antony, 2008).

It is clear from current research that there has been very little research that investigates the relationship between the CSFs for and key barriers to LSS implementation within the SME manufacturing sector. Therefore by considering research undertaken in TQM, Six Sigma and Lean, factors that are proposed as highly important and key enablers in implementation of these initiatives are the competence of the workforce, the strategic vision of the leaders and the culture of the organisation (Hilton and Sohal, 2012; Calvo-Mora *et al.*, 2014). It is these factors that are now considered in developing our hypotheses.

3. Hypothesis development

3.1 Core personal competence and readiness for LSS

The first priority of any quality strategy must be to develop managers and employees' capacity to implement the initiative through improving personal competence (Hilton and Sohal, 2012; Dahlgaard and Dahlgaard-Park, 2006). In fact Maleyeff *et al.* (2012) have indicated that LSS evolution requires radical innovation of people inside the organisation and Cherniss *et al.* (2010) have suggested that emotional, social and intellectual competences (IC) are key success factors for any process improvement strategy including LSS. From the perspective of this research core it is the core IC and emotional competences (EC) that will be investigated here.

EC refer to human sensibility and consist of self-awareness, self-regulation, self-motivation, empathy and socialism (Dahlgaard and Dahlgaard-Park, 2006). Jayaraman *et al.* (2012) has introduced self-awareness as a critical factor for LSS in any organisation. In contrast to the EC, IC are acquisitive factors related to human capabilities, which involve rational and reasoning capabilities developed through training, education and performance management (Dahlgaard and Dahlgaard-Park, 2006). Training is one IC factor that has been defined by Garvan, 1997 cited in Daily *et al.* (2012) as "a planned and systematic effort to modify or develop knowledge, skills and attitudes through learning experiences, to achieve effective performance in a range of activities". Training has been recognised as an essential catalyst for teamwork to occur (Daily *et al.*, 2012). Comprehensive training has been seen as one of the key success factors in LSS deployment in any organisation (Kumar *et al.*, 2011; Antony *et al.*, 2005; Zu *et al.*, 2010; Arnheiter and Maleyeff, 2005), while Aboelmaged (2011) has highlighted the knowledge barrier as the most critical barrier factor which results in failure to accept change and impedes the implementation of LSS. It was also indicated by Manville *et al.* (2012) that intellectual and EC will be further developed through learning. Moreover, research studies have highlighted the role of higher education and knowledge to provide better CI proposals by the workforce within organisations (Maleyeff *et al.*, 2012).

Within the TQM literature, finding and then keeping high quality employees through appraisal and performance management is seen as essential to implementing any quality improvement practice and maintaining a TQM culture (Abu-Doleh, 2012; McElwee and Warren, 2000). Nonetheless, the literature has emphasised that performance appraisal is required to be based on quality criteria and organisational performance measurement rather than individual performance (Jimenez-Jimenez and Martinez-Costa, 2009). However it has also been found from current literature that the core personal competencies of the employees and managers may have significant

impact on TQM culture and consequently readiness for LSS (Abu-Doleh, 2012; Maleyeff *et al.*, 2012; Cherniss *et al.*, 2010; Dahlgaard and Dahlgaard-Park, 2006). Therefore, the first hypothesis to be tested within this SME research is shown below, where the impact of personal competence on readiness to embark on LSS is investigated:

H1. Core personal competence of people in manufacturing SMEs will positively affect the readiness for embarking on LSS.

H1a. Core personal competence of people in manufacturing SMEs has positive impact on the team working eagerness for LSS implementation.

H1b. Core personal competence of people in manufacturing SMEs has positive impact on the eagerness to work with statistics for LSS implementation.

H1c. Core personal competence of people in manufacturing SMEs has positive impact on the background awareness of the LSS.

3.2 Strategic and operational vision and readiness for LSS

Strange and Munford (2002) cited in Gutierrez Gutierrez *et al.* (2009) argue that vision starts from the mental models of individuals, as a function of their goals. Research on the interaction of organisational context and TQM practices found that the choice of TQM practices depends on the manufacturing strategy (Lam *et al.*, 2015; Laohavichien *et al.*, 2011). Organisations embarking on LSS have the power to foster a climate of continuous organisational change by aligning the organisation vision to an excellence model (Pamfilie *et al.*, 2012). Linking LSS to the principles of TQM (Dahlgaard and Dahlgaard-Park, 2006) and also to business strategy (Cheng, 2013) has been acknowledged as essential by the literature. This would encourage researchers to evaluate the vision of people as an enabler for implementing LSS or any other business excellence quality model (Alonso-Almeida and Fuentes-Frias, 2012).

A continuous process improvement methodology and problem solving vision have been suggested as the key constructs for assessing the link between business strategy and LSS (Cheng, 2013; Goh, 2013; Zu and Fredendall, 2009). The quick fix expectation and inadequate long-term commitment to CI have also been recognised as key issues from the perspective of "vision" that may impede the implementation of LSS (Gupta *et al.*, 2012; Antony, 2011, 2012; Cournoyer *et al.*, 2013; Kumar and Antony, 2009). This is congruent with the result of TQM implementation research study that explored the reality of organisational life where the focus is on work force control by senior managers rather than long-term CI. (Soltani and Wilkinson, 2010). This is in contrast with contemporary research (Lam *et al.*, 2015) that recognised CI as the ongoing process improvement with crucial role in a TQM environment.

The vision and insight of the people within organisations towards principles of TQM philosophy will distinguish them from others by selecting the best possible business excellence practice (Kumar and Antony, 2009; Dahlgaard and Dahlgaard-Park, 2006). In relation to this LSS practitioners must also understand the need to align improvement projects with the short and long-term strategies of their organisation and to anticipate the future strategic direction leading to competitive advantage (Maleyeff *et al.*, 2012). This suggests the importance of identifying the people's understanding of strategic direction and key performance indicators (KPIs) inside the organisation in order to prepare them for any quality excellence practice. It is also critical to view any non-value adding and waste activity or practice as a defect and identify them as opportunities for problem solving within an LSS quality excellence vision (Piercy and

Rich, 2015; Atmaca and Girenes, 2013; Antony 2011). Therefore, the second hypothesis to be tested in this research is shown below, where the impact of vision of leaders, managers and employees on readiness to embark on LSS as overall and on constructs of LSS readiness in manufacturing SMEs will be investigated:

H2. Strategic and operational vision of people in manufacturing SMEs will positively affect the readiness for embarking on LSS.

H2a. Strategic and operational vision of people in manufacturing SMEs has positive impact on the team working eagerness for LSS implementation.

H2b. Strategic and operational vision of people in manufacturing SMEs has positive impact on the eagerness to work with statistics for LSS implementation.

H2c. Strategic and operational vision of people in manufacturing SMEs has positive impact on the background awareness of the LSS.

3.3 Organisational culture and readiness for LSS

An appropriate organisational culture has been widely considered as necessity for any TQM practice including LSS (Kanpp, 2015; Antony, 2014, Zu *et al.*, 2010; Mosadegh rad, 2006), whilst more recently the gap in the empirical research examining the association between organisational culture and TQM practices has also been acknowledged (Lam *et al.*, 2015; Baird *et al.*, 2011). Other studies have suggested that organisational culture, leadership and behavioural aspects are soft critical factors in all TQM practices (Calvo-Mora *et al.*, 2014; Laohavichien *et al.*, 2011; Baird *et al.*, 2011). Moreover, organisational belief and culture have been recognised as the moderator between CSFs and LSS implementation in manufacturing industries (Goh, 2013; Jayaraman *et al.*, 2012; Tanik and Sen, 2012). Pisani *et al.* (2009) cited in Tanik and Sen (2012) claim that success and failure of Six Sigma are strongly related to the culture of the society where the projects are carried out.

Collaboration as a characteristic of corporate organisational culture will support the organisational change and successful implementation of any TQM practice (Lam *et al.*, 2015; Baird *et al.*, 2011; Mosadegh Rad, 2006). Cross-functionality of communication and collaboration have been identified as a key factor for a successful LSS project (Choi *et al.*, 2012). People recognition through empowerment, inspiration and involvement in decision making processes have always been an important and challenging cultural construct of successful implementation of LSS (Kanpp, 2015; Antony, 2014; Hilton and Sohal, 2012; Daily *et al.*, 2012; Baird *et al.*, 2011; Zu and Fredendall, 2009; McAdam and Lafferty, 2004). Some empirical research has found support for this argument; for example, Kanpp (2015) and Jimenez-Jimenez and Martinez-Costa (2009) have recommended employees' involvement in decision making and giving flexibility and responsibility to employees as significant constructs to initiate any quality improvement practice. This has even been emphasised as a critical human resource enabler to promote organisational readiness in SMEs (McElwee and Warren, 2000). Moreover, a significant link has been found between people recognition and leadership to facilitate readiness for LSS (Antony, 2014). Leadership has been acknowledged as a key enabler for TQM (Yunis *et al.*, 2013) and it is identified as a necessary factor to oversee the LSS project selection and execution from a strategic perspective (Antony *et al.*, 2012). Senior management leadership has been recognised as the main organisational support and strategy to

promote LSS activities (Choi *et al.*, 2012). It was noted by Kanpp (2015) and Manville *et al.* (2012) that leadership style will facilitate the organisational change initiatives to embark on LSS. A further investigation also suggests that transformational leadership, which focuses on motivating the followers, would promote the participative model of leadership in which the leader's concern for fostering the individual subordinates is demonstrated (Kanpp, 2015; Laohavichien *et al.*, 2011).

Resistance to change has been stated as one of the most profound challenges for management when adopting innovative CI (Baird *et al.*, 2011). Notwithstanding this, there are arguments that manufacturing SMEs have greater advantages than their bigger counterparts in exploitation changes. This is because there are fewer managerial layers, they can be more flexible and therefore be better able to adapt quickly to accept changes (McDermott and Prajogo, 2012). This is an important issue to investigate in manufacturing SMEs, since Choi *et al.* (2012) have argued that LSS will impose process innovation and change through process measurement, analysis and improvement that needs to be adopted by all personnel. Nevertheless it is an organisational responsibility to bring about change when necessary and promote enthusiasm for that change which has been found as a critical factor in LSS deployment (Manville *et al.*, 2012; Choi *et al.*, 2012).

It was indicated in the literature that establishment of a quality-orientation culture is an essential element to be developed before the potential application of LSS (Hensley and Dobie, 2005; Arnheiter and Maleyeff, 2005). This must also be aligned with the core cultural values of the organisation as trust, respect, integrity, loyalty, justice and honesty if the initiative is to be successful (Kanpp, 2015; Lam *et al.*, 2015; Dahlgaard and Dahlgaard-Park, 2006). Therefore, the third hypothesis to be tested within this research is developed as shown below, where the impact of organisational culture on readiness to embark on LSS as overall and on constructs of LSS readiness in manufacturing SMEs will be investigated:

H3. Organisational culture of people in manufacturing SMEs will positively affect the readiness for embarking on LSS.

H3a. Organisational culture of people in manufacturing SMEs has positive impact on the team working eagerness for LSS implementation.

H3b. Organisational culture of people in manufacturing SMEs has positive impact on the eagerness to work with statistics for LSS implementation.

H3c. Organisational culture of people in manufacturing SMEs has positive impact on the background awareness of the LSS.

3.4 Hypothesis model for German manufacturing SMEs

As has already been stated the research took place within the German SME manufacturing sector where little empirical research on LSS has been undertaken. The literature thus far has indicated the importance of personal competence, strategic vision and culture of the organisations in embarking on LSS projects. This theoretical discussion has further been contextualised to the manufacturing SMEs sector. However, it was also previously acknowledged by literature that there is limited rigorous research in relation to the role of human factors in LSS implementation within manufacturing SMEs (Kaushik *et al.*, 2012; Antony *et al.*, 2012; Atmaca and Girenes, 2013). The German SME manufacturing sector was selected as the site of data collection for this study because Kinkel *et al.* (2014) have indicated that in general their

future manufacturing strategy is based upon policies which focus on low cost, high market share and high skill and knowledge management. LSS has the potential to play a large part in facilitating this strategy. The role of human factors especially in the context of teamwork in German manufacturing have also been emphasised by previous research studies (Bikfalvi, 2011). Thus a study to investigate the readiness of personnel in German manufacturing SMEs to embark on LSS as a systematic business excellence tool to promote both low cost and high revenue appears to be warranted. Based on the literature review the hypothesis model shown in Figure 1 was generated in order to identify the significance of the relationship between the three human factors of core personal competence, vision and culture with LSS readiness. Our research then investigates the most significant predicting factor of LSS readiness and its constructs for German manufacturing SMEs. Figure 1 also depicts the second layer of hypothesis testing in which the impact relationship between each of the three human-related behavioural factors and each individual component of LSS readiness is tested.

4. Research methodology

This section provides detailed insight into data collection, sampling and the data analysis techniques used within our research. All targeted German SMEs were from the manufacturing sector. The sampling method was purposive sampling where there was no sampling frame, but a specific sector or case study is targeted (Saunders *et al.*, 2012).

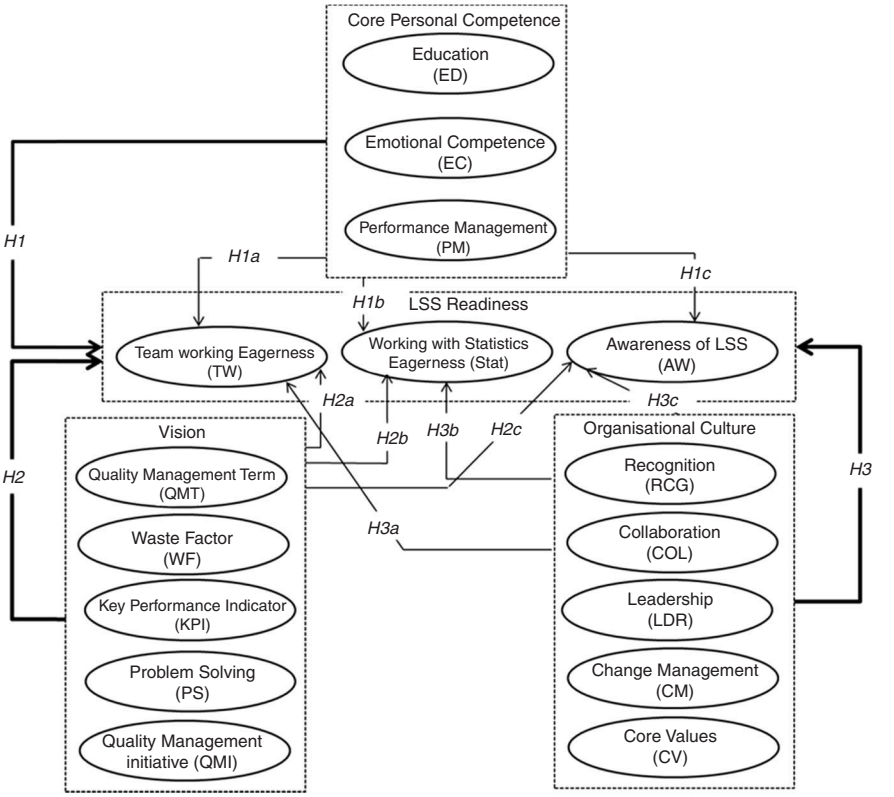

Figure 1.
Hypothesis model for the research methodology

In this study seven German manufacturing SMEs were randomly selected from the Amadeus Database based on the criteria that they should have between 40 and 100 employees, sit within a substantial supply chain such as food, automotive or aerospace, have a relative longevity and be willing to participate in the study. There was also a necessity to cluster the organisations to make travel to them relatively easy. After careful consideration the research team identified two clusters, one in the north-west of Germany where three SMEs in the food manufacturing supply chain were selected and a further cluster of four SMEs in the south west of Germany where there was heavy manufacturing for the automotive and aerospace supply chain. Food manufacturing sector was selected to represent as perishable, low margin and high volume product (Bamford *et al.*, 2015) in one side of the spectrome, whilst heavy automotive and aerospace manufacturing represents the opposite side of the spectrome. Each SME was initially contacted by the UK researchers to assess suitability for the study and then a visit to the companies was arranged. At the visit the research was explained to the senior team and the methodology and ethical consideration for data collection within their organisation was detailed. This involved a structured questionnaire (Appendix 1) to be given to all personnel within all seven organisations. The targeted population included directors, deputy directors, line managers, department managers, consultants and all employees from different departments including sales and marketing, purchasing, production, design, logistics and finance.

The questionnaire was developed after an extensive review of the literature related to Six Sigma, LSS and also HR and TQM. The questionnaire consisted of three main sections; the first section included three questions about the department, position and years of experience each employee had in the organisation. The second section focused on behavioural factors as enablers of LSS and was constructed with 13 questions that each reflected one construct for each factor. The "Personal Competence" factor covered three constructs and questions, where respondents could select more than one variable. The "Vision" and "Organisational Culture" factors each covered five constructs and questions, which respondents again could select more than one option for most of the questions. Further details about the constructs and variables are presented in Table I. The theoretical validity to investigate these specific constructs is evident in last column of Table I by providing one of the main and current supportive literature sources for each construct. The appropriateness of selecting the questionnaire as a data collection instrument for these constructs such as EC has been validated by the literature. For instance, Jayaraman *et al.* (2012) have particularly used survey questionnaire to analyse the behavioural-related CSFs of LSS including the EC. Having had an initial productive visit to each case study, authors also were satisfied with the adequate self-knowledge of respondents to interpret the terminology correctly without necessity of any researchers' intervening.

The last section of the questionnaire included five questions about LSS constructs such as "eagerness for teamwork", "eagerness to work with statistics" and "terminology awareness". The answer to these questions was either "Yes" or "No". Once designed, the questionnaire was translated to the German language and pre-tested by ten employees from different positions in one of the targeted SMEs. This process enabled the clarification of possible ambiguities, correction of errors and issues of formatting.

It was decided to use both correlation and regression analysis in order to investigate the relationship between constructs in more detail. Constructs have been presented mainly with dummy variables that are distinguished with "zero" and "one" for selecting

Table I.
Constructs and their variables for each hypothesis

Enablers	Construct	Variables	Type of variables	Literature source
Core personal competence	Education	Doctorate, master, bachelor, HND, A-level, less than A-level	Categorical	Aboelmaged (2011)
	Emotional competence	Self-awareness, self-regulation, self-motivation, emphatic, social	Dummy	Dahlgaard and Dahlgaard-Park (2006)
	Performance management	In-house training, short courses, regular appraisal	Dummy	Abu-Doleh (2012)
Strategic and operational vision	Vision for quality improvement term	Quick fix, long term, CI	Dummy	Gupta *et al.* (2012)
	Vision for waste	Inventory, over production, over processing, waiting time, manufacture to stock, guarantee, final product inspection, skill miss-utilisation, defective product, machine set-up time, excessive staff movement, customer complaint department	Dummy	Antony (2011)
	Vision for KPIs	Quality, cost, flexibility, reliability, speed, innovation, safety, profit	Dummy	Maleyeff *et al.* (2012)
	Vision for problem solving methodology	No procedure required, statistical approach is required, cross-functional involvement, systematic methodology is required	Dummy	Cheng (2013)
	Vision for most suitable quality initiatives	ISO9000, TQM, lean, LSS, none	Dummy	Kumar and Antony (2009)
Organisational culture	Collaboration	Depth of collaboration, range of collaboration	Categorical	Choi *et al.* (2012)
	Employee recognition	Involvement in decision making, rewards, willingness to participate, fear factor	Dummy	Antony (2014)
	Leadership style	Dictatorial, democratic, participative, goal-oriented, situational	Categorical	Antony *et al.* (2012)
	Vision of change initiation	Rewarding, exciting, fearful, hateful	Dummy	Choi *et al.* (2012)
	Core values	Dignity, trust, goodness, loyalty, honesty, justice, respect	Dummy	Dahlgaard and Dahlgaard-Park (2006)

or not selecting the variable (Field, 2009), although there have been some constructs with categorical data represented numerically. Table I represents details of constructs and their variables for each hypothesis.

As a result of the literature review (Antony, 2014; Lee *et al.*, 2011), it was decided to construct the LSS readiness through three different factors including eagerness to work in teams, eagerness to work with data and statistics to solve problems and awareness of LSS or Six Sigma. Teamwork and statistics have been suggested as key pillars for LSS implementation and sources of shared vision and setting stretching goals (Antony, 2014; Tanik and Sen, 2012; Gutierrez Gutierrez *et al.*, 2009). In the more technical aspects of implementation, statistical tools in LSS are oriented to very specific goals such as detecting the causes of errors, reasons for deviations and calculation of the number of defects that make LSS the strongest TQM practice from statistical perspective (Gutierrez Gutierrez *et al.*, 2009). Furthermore, teamwork has been recognised as central to any quality improvement practice, because it involves the collaboration between management and employees to facilitate CI and problem Solving (Lam *et al.*, 2015; Jimenez-Jimenez and Martinez-Costa, 2009; Gutierrez Gutierrez *et al.*, 2009). Research studies have found teamwork as the vehicle to manifest change (Daily *et al.*, 2012) and more congruence between different levels of management is a required element in a top-down approach quality practice such as LSS to promote teamwork (Soltani and Wilkinson, 2010).

Further details about sections, the number of questions in each section, the theme of each question and relative studied constructs to questions have been presented in Table II. The numbers presented under the "theme of questions" represent the actual question on survey questionnaire.

Section	Number of questions	Theme of each question	Relative studied construct	Comment
1. General questions	4	(1) position, (2) department, (3) experience	n/a	Single-choice options
		(4) highest qualification	Education	
2. Behavioural factors	12	(5) personality, (6) performance management	Emotional and intellectual competence	Multi-choice options
		(7) vision of quality management, (8) waste, (9) KPI, (10) un-known problem solving, (11) quality improvement practice	Vision	Multi- and single-choice options
		(12) information sharing, (13) employee involvement and empowerment, (14) decision making style, (15) feeling about change, (16) feeling valued ISO9000, TQM, lean, LSS, none	Collaboration, recognition, leadership, change management, core values	Multi- and single-choice options
3. LSS	5	(17) Teamwork, (18) Statistics, (19) Awareness of LSS (20) and (21) Usefulness of LSS	LSS readiness	Multi- and single-choice options

Table II. Details of sections and questions in survey questionnaire

5. Finding and analysis

Having circulated the survey to all 485 managers and employees of seven manufacturing SMEs in Germany by manual distribution, 121 responses were received. After an initial review of the returned questionnaires, nine were dismissed due to incompleteness. This left 112 valid questionnaires, representing 23 per cent of total workforce in these organisations. Figure 2 represents some descriptive statistics about departments, positions and experience of the respondents. It was observed that around 38 per cent of respondents were from production departments, while 11 per cent of the respondents were the senior executive managers. The rationale for having five years' experience intervals within the survey instrument relates to economic problems that challenged the industry and the EU five years ago. The majority of these organisations have tended to employ permanent labour with a small percentage using seasonal or temporary staff. Within the survey it was also found that only 13 per cent of the personnel had a higher education qualification, whilst 67 per cent of them had been educated below diploma level. These lesser qualified staff were mainly production personnel. The internal consistency and reliability amongst variables in each construct needed to be tested by calculating Cronbach's α (Calvo-Mora *et al.*, 2014; McDermott and Prajogo, 2012). The result of the Cronbach's α analysis for all constructs of three human-related enabling factors was between 0.793 and 0.898 and therefore acceptable (more than 0.70).

5.1 Correlation analysis for association between three people-related enabling factors and LSS readiness

Table III presents the result of the correlation coefficient analysis that was extracted from data analysis through SPSS statistical software. The correlation coefficient indicates the degree of relationship between variables. This analysis provides the overall association between the LSS readiness and other three people-related behavioural and enabling factors. The overall correlation analysis presented by the correlations matrix in Table III found significant positive association between core personal competence of personnel and their readiness to embark on LSS with correlation coefficient of $r = 0.552$ and sig. value < 0.01. It was also found that there is a significant positive association between organisational culture of personnel and their readiness to embark on LSS with correlation coefficient of $r = 0.566$ and sig. value < 0.01. In contrast, no significant correlation between strategic and operational vision of personnel with their readiness for embarking on LSS has been found in 95 per cent coefficient confidence (sig. value > 0.05). This initial finding has encouraged the researchers to explore more of the details about the level of impact from constructs of core personal competence and organisational culture as predictor variables on LSS readiness and its constructs as an outcome variable through regression analysis.

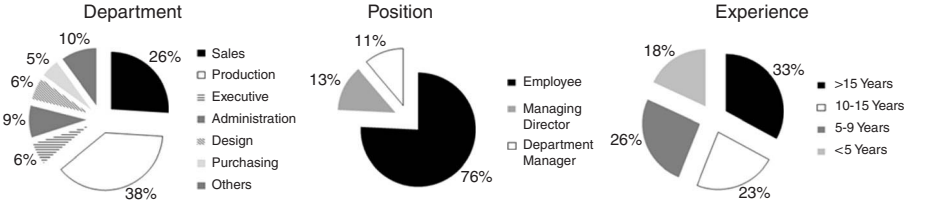

Figure 2.
Organisational descriptive statistics for seven respondents

	Correlations Core personal competence	Vision	Culture	LSS
Spearman's ρ				
Core personal competence				
Correlation coefficient	1.000	0.101**	0.297**	0.552**
Sig. (2-tailed)	–	0.000	0.000	0.000
n	1,232	1,232	1,232	336
Vision				
Correlation coefficient	0.101**	1.000	0.015	−0.056
Sig. (2-tailed)	0.000	–	0.497	0.310
n	1,232	3,584	2,015	336
Culture				
Correlation coefficient	0.297**	0.015	1.000	0.566**
Sig. (2-tailed)	0.000	0.497	–	0.000
n	1,232	2,015	2,015	336
LSS				
Correlation coefficient	0.552**	−0.056	0.566**	1.000
Sig. (2-tailed)	0.000	0.310	0.000	–
n	336	336	336	336

Note: **Correlation is significant at 0.01 level (two-tailed)

Table III.
Matrix of correlation analysis

5.2 *The impact analysis of core personal competence and LSS readiness (H1)*

The result of regression analysis on the relationship between core personal competence and LSS readiness (*H1*) has revealed there is an acceptable significant impact of core personal competence constructs on LSS readiness with sig value < 0.01. However, the sig. value result of multiple regression analysis (Table IV) revealed that none of the impact relationships between constructs of core personal competence and LSS readiness were significant in 95 per cent coefficient confidence (sig. value > 0.05). Therefore, no significant difference was found through a multiple regression analysis between education, EC and performance management as predictors for LSS readiness. This indicates that none of these factors have profound importance in enhancing LSS readiness through improving the core personal competence of the workforce.

Further simple regression analysis for the impact relationship between core personal competence as predictor and three different constructs of LSS readiness was conducted. It was revealed that core personal competence has a strong impact only on eagerness to work with statistics (*H1b*) with sig. value < 0.05 in 95 per cent coefficient confidence. Therefore, unlike *H1b*, the null hypothesis for *H1a* and *H1c* were accepted

	Parameter estimates						95% confidence interval for exp(*B*)	
LSS[a]	*B*	SE	Wald	df	Sig.	Exp (*B*)	Lower bound	Upper bound
0.00 Intercept	−2.407	1.261	3.645	1	0.056			
Education vs LSS	0.107	0.180	0.349	1	0.555	1.112	0.781	1.584
Emotional competence vs LSS vs	0.026	0.823	0.001	1	0.975	1.027	0.205	5.148
Performance management vs LSS	−0.353	0.592	0.355	1	0.551	0.703	0.220	2.244

Note: [a]The reference category is 1.00

Table IV.
Multiple regression analysis of relationship between core personal competence variables and LSS readiness

as no strong impact was found. This means that improving core personal competence of the personnel will improve eagerness to work with statistics significantly as an enabler for successful LSS commencement. However, further multi-regression analysis revealed that role of education on eagerness to work with statistics was more significant than other core personal competence measures with sig. value < 0.05 in 95 per cent coefficient confidence (see Table V). This indicates that improving education must be a priority of personal competence improvement to promote eagerness to work with statistics, whilst performance management improvement and EC would have no priority to each other. This result also recognises that other LSS readiness constructs such as eagerness to work in team and also level of LSS awareness would not be affected by core personal competence improvement significantly.

5.3 The impact analysis of vision and LSS readiness (H2)

The result of simple regression analysis on the impact relationship between strategic and operational vision of personnel and LSS readiness was consistent with the correlation coefficient analysis presented in Table III and no significant impact of people's vision on LSS readiness was found. Further simple regression analysis for the impact relationship between vision as predictor and three different constructs of LSS readiness was also conducted. It was revealed that vision has a strong impact on only eagerness to work with statistics (*H2b*) with sig. value < 0.05. Therefore, unlike *H2b*, the null hypothesis for *H2a* and *H2c* were accepted as no strong impact was found. This means that enhancing vision of the personnel will improve eagerness to work with statistics significantly as an enabler for successful LSS commencement.

However, further multi-regression analysis revealed that the role of "vision towards quality management (QM)" on eagerness to work with statistics was more significant than other measures such as KPI and waste recognition with sig. value < 0.05 (see Table VI). This means that changing the vision of QM must be a priority of organisational vision to promote eagerness to work with statistics. This is consistent with research that suggests people who recognise QM as a quick fix and do not believe on process CI would not be prepared for LSS. This result would also recognise that other LSS readiness constructs such as eagerness to work in teams and also level of awareness of LSS would not be affected significantly by changes to the employees' vision.

5.4 The impact analysis of organisational culture and LSS readiness (H3)

It was also found from simple regression analysis that there is an acceptable significant impact of organisational culture on LSS readiness with sig. value < 0.05. The result of multiple regression analysis has suggested that "core values" construct as one of the predictor variables of the organisational culture has significant priority

Table V.
Multiple regression analysis of impact of core personal variables on eagerness to work with statistics

	Variables in the equation					
	B	SE	Wald	df	Sig.	Exp(*B*)
Step 1[a]						
Education	0.308	0.120	6.654	1	0.010	0.735
Emotional competence	−0.151	0.576	0.069	1	0.793	0.860
Performance management	0.179	0.422	0.180	1	0.671	1.196
Constant	1.334	0.827	2.603	1	0.107	3.796

Note: [a]Variable(s) entered on step 1: education, emotional competence, performance management

to maintain LSS readiness with sig. value < 0.05, and the rest of the constructs had no significant priority over others (Table VII). This means that focusing on improving "core values" of the personnel could be considered as a priority to ensure the readiness of the people for LSS.

Further simple regression analysis for the impact relationship between organisational culture as a predictor and three different constructs of LSS readiness was conducted. It was revealed that organisational culture also has a strong impact only on eagerness to work with statistics (*H3b*) with sig. value < 0.05. Therefore, unlike *H3b*, the null hypothesis for *H3a* and *H3c* were accepted as no strong impact was found. This means that enhancing organisational culture of the personnel will improve eagerness to work with statistics significantly as an enabler for successful LSS commencement. However, further multi-regression analysis revealed there is no significant difference between variables of organisational culture to promote eagerness to work with statistics (see Table VIII). This means that there would be no cultural priority to promote working with statistics, and all variables are similarly important. This was different to the results of the impact analysis between organisational culture variables and overall LSS readiness (Table VII), where core values had the highest priority. This result would also recognise that other LSS readiness constructs such as eagerness to work in teams and also level of LSS awareness would not be affected significantly by cultural improvement. Surprisingly, no significant relationship was found between cultural variables such as leadership and core values with teamwork element of LSS readiness in these samples.

	Variables in the equation					
	B	SE	Wald	df	Sig.	Exp(*B*)
Step 1[a]						
Vision of QM	1.505	0.699	4.635	1	0.031	0.222
Vision of Waste	0.172	0.488	0.124	1	0.725	1.187
Vision of KPIs	0.673	0.726	0.861	1	0.353	1.961
Vision of problem solving methods	0.341	0.432	0.624	1	0.430	1.407
Vision of QM initiatives	1.177	0.646	3.324	1	0.068	3.245
Constant	1.253	0.727	2.973	1	0.085	0.286

Note: [a]Variable(s) entered on step 1: QM vision, waste, KPIs, problem solving, QM initiatives

Table VI. Multiple regression analysis of impact of vision variables on eagerness to work with statistics

		Parameter estimates							
								95% confidence interval for Exp(*B*)	
LSS[a]		*B*	SE	Wald	df	Sig.	Exp(*B*)	Lower bound	Upper bound
0.00	Intercept	−1.966	0.957	4.222	1	0.040			
	Collaboration vs LSS	0.001	0.169	0.000	1	0.994	1.001	0.719	1.393
	Recognition vs LSS	−0.892	0.653	1.864	1	0.172	0.410	0.114	1.475
	Leadership vs LSS	0.024	0.242	0.010	1	0.920	1.025	0.638	1.646
	Change vs LSS	−0.373	0.647	0.333	1	0.564	0.688	0.193	2.449
	Core values vs LSS	1.548	0.627	6.091	1	0.014	4.704	1.375	16.088

Note: [a]The reference category is 1.00

Table VII. Multiple regression analysis of relationship between organisational culture variables and LSS readiness

The summary of association analysis is shown in the hypothesis model (Figure 3), since further impact analysis was done earlier as the result of regression analysis. The model in Figure 3 is the updated version of the conceptual model (Figure 1) and illustrates the details of the hypothesis testing. In fact, Figure 3 depicts the significance of the relationship between each behavioural factor with LSS readiness and its constructs. In the diagram any relationship hypothesis represented by stars (two stars represent stronger association than one star) indicates association between variables, discussed previously.

Table VIII. Multiple regression analysis of impact of organisational culture variables on eagerness to work with statistics

	Variables in the equation					
	B	SE	Wald	df	Sig.	Exp(*B*)
Step 1[a]						
Recognition	0.800	0.433	3.408	1	0.065	2.226
Change	0.578	0.419	1.901	1	0.168	1.782
Core values	−0.342	0.498	0.472	1	0.492	0.710
Leadership	0.205	0.160	1.646	1	0.200	1.227
Collaboration	0.187	0.123	2.286	1	0.131	1.205
Constant	−2.180	0.715	9.292	1	0.002	0.113

Note: [a]Variable(s) entered on step 1: recognition, change, core values, leadership, collaboration

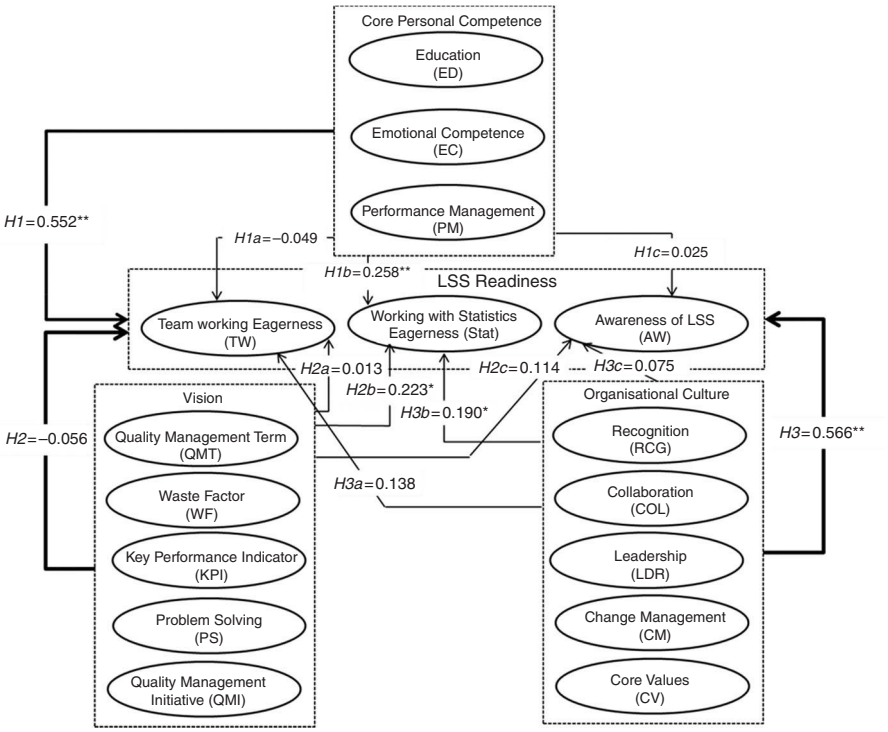

Figure 3. Hypothesis model with the result of association analysis

6. Research and practical implications

This research study has been undertaken through rigorous primary data collection in German manufacturing SMEs and has responded to the call for more empirical work to be done within the LSS implementation area of the literature (Shokri *et al.*, 2014; Thomas *et al.*, 2014; Zhang *et al.*, 2012; Antony, 2012). The results presented in this paper have concurred with theoretical research found in the literature that the most important LSS success and failure factors are top management commitment and resistance to change (Shokri *et al.*, 2014; Thomas *et al.*, 2014; Assarlind *et al.*, 2013; Antony, 2012; Delgado *et al.*, 2010; Desai *et al.*, 2012; Choi *et al.*, 2012; Jayaraman *et al.*, 2012; Lee *et al.*, 2011). In fact, this research study has emphasised the human behavioural-related aspects of these factors and more importantly revealed key human resource elements to support LSS implementation. This research is also congruent with the study of Bamber *et al.* (2014), Albliwi *et al.* (2014) and Tanik and Sen (2012) whose conclusions about the significant impact of culture, educational level and knowledge of statistics on the success of Six Sigma projects is seen as equally important in German SMEs.

Although the study presented here only considered seven SMEs within the German manufacturing supply chain it has addressed to some extent the research gap (Atmaca and Girenes, 2013; Thomas and Barton, 2006) of human behavioural factors and their relationship with LSS. Moreover, this research developed more in-depth analysis of the people-related success and failure factors in implementing LSS in SMEs that have already been identified by literature and variety of authors (Prashar, 2014; Antony, 2012; Aboelmaged, 2011; Choi *et al.*, 2012; Kumar *et al.*, 2009).

The result of this research study in German manufacturing SMEs supports Albliwi *et al.* (2014) and Cherniss *et al.* (2010) that developing EC and IC are key success factors in facilitating LSS in SMEs. But, unlike the study from Jayaraman *et al.* (2012), this research study did not recognise self-awareness as a prioritised factor for implementing LSS in manufacturing SMEs. In fact, there appears to be no difference between the factors of emotional and IC and their impact on LSS readiness. However, when the constructs of LSS readiness were analysed individually, then it was found that working with data and statistics is the only LSS readiness construct that will be affected by the EC and IC significantly, where educational enhancement plays the most significant role as an IC factor to promote working with statistics. This is consistent with the study conducted by Aboelmaged (2011) who has highlighted the knowledge barrier as the key factor in failing to accept change and LSS in SMEs. The result of this research has also been consistent with the argument from Maleyeff *et al.* (2012) who have proposed that undertaking higher education is an enabler for CI practices in any organisation.

Although the connection between LSS and business strategy has been recommended by Cheng (2013) as a key success factor for LSS in any organisation, the result of this study has found no significant impact between vision and LSS readiness for manufacturing SMEs. This suggests that people with different types of vision about quality improvement, waste reduction and KPI vision have the same capacity to be prepared for the LSS projects in manufacturing SMEs. However, when the constructs of LSS readiness were analysed individually, then it was found that working with data and statistics is the only LSS readiness construct that will be affected by the people's vision significantly, where improvement of vision about CI and process improvement play the most significant role in promoting working with statistics. This was consistent with the result of studies by Gupta *et al.*(2012), Antony (2012), Cournoyer *et al.* (2013) and Soltani and Wilkinson (2010), who suggest that

"quick fix" expectation and inadequate long-term commitment towards CI as key individuals' visions will have a negative effect on organisations willingness to implement LSS.

The result of this research is also consistent with the studies undertaken by Kanpp (2015), Lam *et al.* (2015), Antony (2014), Bamber *et al.* (2014), Stanton *et al.* (2014), Zu *et al.* (2010), Calvo-Mora *et al.* (2014), Laohavichien *et al.*(2011), and Baird *et al.* (2011) who argue that organisational culture and behavioural factors are key enablers for any TQM practice including LSS. This study has found a strong relationship between organisational culture and readiness to implement LSS in German manufacturing SMEs. The result of this study was also consistent with the study from Kanpp (2015), Lam *et al.* (2015) and Dahlgaard and Dahlgaard-Park (2006) who propose that core values such as trust, respect, integrity, loyalty, justice and honesty are critical factors within the organisational culture and also part of the core competence to promote LSS. However, when the constructs of LSS readiness were analysed individually, then it was found that working with data and statistics is the only LSS readiness construct that will be affected by the organisational culture significantly, where no specific cultural measure plays the pre-dominant role to promote working with statistics. This means that although core values are the key people-related factors to be considered as the first stage of improving LSS readiness for manufacturing SMEs, they have no greater importance than other cultural variables when developing people's eagerness to work with statistics.

Overall, the results of this study support the arguments of Antony (2014), Tanik and Sen (2012) and Gutierrez Gutierrez *et al.* (2009) who have recommended that statistical ability is a key pillar of any LSS implementation and source of goal setting for manufacturing SMEs. In response to the previous literature (Antony, 2014; Tanik and Sen, 2012; Gutierrez Gutierrez *et al.*, 2009), this study did not suggest any prioritised human-related variable to propose "eagerness for teamwork" as a key factor for LSS readiness in manufacturing SMEs and identified all variables in a same level of importance to promote teamwork. This suggests that managers in the German manufacturing SMEs within this study would need to emphasise the core values of people as a foundational element to promote LSS readiness. Then, they need to support employees' personal development through higher education in order to change the quality improvement vision towards CI, to facilitate eagerness for statistical data collection and analysis, and this would lead to cultural enhancement prior to taking any step towards LSS implementation.

7. Concluding remarks and future work

This research study has been conducted through systematic empirical data collection which has investigated the human and behavioural factors identified as being critical when commencing LSS in manufacturing SMEs. This study has empirically demonstrated that human and behavioural factors are highly important when implementing LSS in manufacturing SMEs. Although some theoretical aspects of the LSS literature is confirmed, it is important to recognise that this study has taken this work further. In analysing the CSFs of implementing LSS within the context of German manufacturing SMEs it has moved beyond the technical and methodological focus to a highly challenging area of "softer" factors which many researchers would prefer to avoid investigating. This study has found that managers and their staff, with diverse quality and waste reduction visions, can be ready to embark upon an LSS implementation since our results show no relationship between people's vision and

readiness for LSS. However, in the German sample it can be seen that it is necessary to enhance core personal competencies and the organisational culture of the business before even beginning to promote any LSS programme. Core values such as dignity, trust, goodness, loyalty, honesty, justice and respect cannot be ignored and addressing these aspects of culture must be prioritised in order to enable top management commitment and combat resistance to change. Nevertheless identifying these values is just the beginning and further detailed analysis of each individual element of core values (e.g. dignity, trust.) could be considered for future research studies. It is also essential that any preparatory work on LSS readiness is underpinned with an eagerness to work with statistical data that in many cases will only be achieved through education.

In terms of further research the results of this study could not only be explored on a larger scale but also within other cultural environments where the quality agenda within manufacturing is becoming increasingly important and where LSS may be an appropriate approach. Moreover, it is acknowledged by authors that other factors or constructs could have also been analysed such as professionalism as a core competence factor and this is an opportunity for further work. The work carried out within our study might also be applicable within the service sector. It is acknowledged that sample size with only seven case studies of three sectors from two different sides of the spectrome could possibly affect the generalisation of the findings to other German manufacturing SMEs. However, this study could ignite an interest for further and broader investigation towards appreciation of the human-related factors to promote LSS in German manufacturing SMEs. This specific research study could also be extended to further analysis of two different sectors of manufacturing SMEs or between two different countries and with a triangulation methodology, which enables both a quantitative and qualitative approach towards data collection. It is clear that this work carried out on a much larger scale could in the future be generalised to a wider population in terms of increasing the number of case studies, sectors and also broadening the reach to different countries in the Europe.

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Appendix. Copy of questionnaire

1. What is your current position in this Company?

☐ Managing Director ☐ Deputy Director ☐ Consultant ☐ Manager
☐ Employee ☐ Other (please, specify:)

2. In which department are you working now?

☐ Executive Team ☐ Production ☐ Marketing ☐ Quality ☐ Purchasing
☐ Logistics ☐ Design ☐ Sales ☐ Training and Consultancy ☐ Finance & Administration ☐ Other (please, specify:)

3. How many years of working experience do you have in this Company?

☐ More than 15 years ☐ 10 - 15 years ☐ 5 - 9 years ☐ 1 - 4 years ☐ Less than 1 year

4. What is your current highest qualification level?

☐ PhD ☐ Master Degree ☐ Bachelor of Engineering ☐ Other Bachelor Degrees
☐ Higher National Diploma ☐ Diploma ☐ A-Level ☐ Below A-Level

5. How do you feel about your personality (please, tick as many applicable options as possible)?

☐ Fully aware of my weaknesses, strengths, preferences and feelings
☐ Able to control my own feeling, and stress
☐ A good self-motivator
☐ Able to know other colleague's feelings and needs
☐ Able to build relationship with others and influence others

6. How your performance is managed in your organisation (please, tick as many applicable options as possible)?

☐ Regular in-house training ☐ Going to short courses ☐ Regular Appraisal Meetings
☐ Regular Supervision ☐ None of these

7. Which of these do you think is correct to improve quality of a product (please, tick as many applicable options as possible)?

☐ It must be quick ☐ It must be started from processes involved
☐ It must be continuing all the time ☐ It needs a long term commitment by everybody

8. **Which of these do you class as waste for the Company (please, tick as many applicable options as possible)?**

- ☐ Raw material in storage
- ☐ Piles of Finished stock in storage
- ☐ Waiting time between processes of production
- ☐ Manufacturing the products based on forecast
- ☐ Having guarantee services for all products
- ☐ Inspection of final product before despatch
- ☐ Producing too many defective products
- ☐ Excessive staff movement in shop floor
- ☐ Using a trained engineer in customer service department
- ☐ Having Customer Complaint Department in the Company

9. **Please, select maximum three key performance indicators for the Company, which are critical for the next year(s).**

☐ Quality ☐ Cost ☐ Flexibility ☐ Reliability ☐ Speed ☐ Innovation
☐ Safety ☐ Profit

10. **If any problem with unknown solution happens in the Company, which of these do you agree with (please, tick as many applicable options as possible)?**

- ☐ We have no specific procedure for that
- ☐ We can't do anything with problems with no solutions on agenda
- ☐ Data and statistical tools are useful to solve these problems
- ☐ All relevant people must be involved to solve these problems
- ☐ We must have a systematic and standard method to deal with all problems straight away

11. **Which of these quality improvement practices can be suitable for the Company (please, tick as many applicable options as possible)?**

- ☐ ISO9000
- ☐ Involving everybody to improve quality and customer satisfaction
- ☐ Waste reduction
- ☐ We don't need to have any specific quality management practice
- ☐ A better systematic, data driven and rigorous quality improvement practice

12. **How is the situation of collaboration and information sharing between your department and other departments in your Company?**

- ☐ Very detailed collaboration with all departments
- ☐ Very detailed collaboration with a few departments
- ☐ Limited collaboration with all departments
- ☐ Limited collaboration with a few departments
- ☐ Moderate collaboration with some departments

13. Which of these is true about you in this Company (please, tick as many applicable options as possible)?

- ☐ I am normally involved in decision making process and discussions for relevant matters
- ☐ I usually receive rewards for a good performance or idea
- ☐ I am willing to be part of decision making process in relevant matters
- ☐ I have a fear of losing my job or respect by giving any suggestions or comments

14. Which of these decision - making styles does fit best for your Company?

- ☐ Decisions are made by managers without consultation
- ☐ Managers receive inputs and then make decisions
- ☐ Teams make decisions not individuals
- ☐ Managers make decision based on situation
- ☐ Managers set objectives and goals first and then make decision based on them

15. How do you feel about any changes in your Department or Company (please, tick as many applicable options as possible)?

☐ Rewarding ☐ Exciting ☐ Fearful ☐ I hate it ☐ No Comment

16. How many of these factors do you think are fully met in your Department or Company (please, tick as many applicable options as possible)?

☐ Dignity ☐ Trust ☐ Goodness ☐ Loyalty ☐ Honesty
☐ Justice ☐ Respect

17. **Do you like working in a team to solve a problem?** ☐ Yes ☐ No

18. **Do you like working with data and statistics?** ☐ Yes ☐ No

19. Are you aware of a problem solving methodology called "Lean Six Sigma" or "Six Sigma"?

☐ Yes ☐ No

If Yes, please go to question 20

If No, please end the questionnaire now and thank you for your support

20. Do you think if Lean Six Sigma or Six Sigma is useful for your Company or department?

☐ Yes ☐ No

If Yes, please end the questionnaire now and thank you for your support

If No, please go to question 21

21. Why do you think it is not useful?

☐ It is too expensive and too complicated for us ☐ It is not for us

☐ We can use other tools or methodologies ☐ Not known

Please, provide any other comments here:

Thank you for your participation!

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